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SOLID WASTE MANAGEMENT PRACTICES IN A PLASTICS PRODUCTION PLANT

William T. Dehn, et al

Bureau of Solid Waste Management
Rockville, Maryland

1970

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IN A PLASTICS PRODUCTION PLANT

A Division of Technical Operations
Open-File Report (TO 5.0/0)

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IN A PLASTICS PRODUCTION PLANT

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written by
WILLIAM T. DEHN and DENNIS E. CARRUTH

Details of illustrations in
this document may be better
studied on microfiche.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Solid Waste Management
1970

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PREFACE

Almost every industrial plant produces some solid waste which must be collected and disposed of. Unfortunately, information on both the amounts and types of solid waste generated and on the solid waste management practices of industrial establishments is not readily available.

Technological growth in any field depends heavily on a good foundation of basic data and a knowledge of existing practices. Unless information and data on the quantities and characteristics of industrial solid waste and the present practices of solid waste management industry are developed, industrial solid waste management technology cannot be expected to advance and keep pace with other industrial and scientific achievements.

The Bureau of Solid Waste Management has the responsibility to accelerate the technology of solid waste management. As a result, the Bureau initiated studies to collect information and data on industrial solid waste management. These studies are being conducted on a national basis by research and consulting firms. In addition to the national studies, the Bureau is also conducting a series of case studies at industrial plants.

This report presents the information collected from one case study. Readers should bear in mind that the waste management practices of industry vary from plant to plant and that the

information presented should not be considered representative of industry as a whole. Furthermore, although this report may contain evaluations, conclusions and/or recommendations, the report is not intended to be a critique of the solid waste management practices of the plant. Its purpose is solely to provide information and data on the state-of-the-art of industrial solid waste management practices.

SUMMARY

A study of solid waste generation, storage, collection, and disposal was conducted at a plastics production plant during the fall of 1968. A study team observed the normal solid waste management practices within the plant during one week. Additional data and information, unavailable during the field study, were obtained through written request to the company.

The solid wastes were categorized as either process waste or nonprocess waste. An analysis of records for 1967-68 revealed that weekly solid waste generation varies from 126,400 pounds to 548,000 pounds with 368,040 pounds of solid waste generated during the week of the field study.

Solid waste handling in the plant involves several complex storage-transfer-collection systems. Storage consists of six open storage areas, two systems of storage containers, and a central transfer area. The six storage areas provide temporary storage for process waste generated from within the production buildings. The waste from these storage areas is transported either directly to a landfill disposal site or to the transfer area. At the transfer area compactable wastes are placed in a stationary compactor while difficult-to-handle wastes such as process syrups, discarded barrels, etc. are placed in storage containers. These containers are hauled directly to a landfill.

Various types of storage containers are used for storage of both process waste and nonprocess waste. Thirty Dempster* containers are used to store primarily nonprocess waste. A front loading Dempster-Dumpmaster collects the waste from these containers and transports it to the transfer area where it is loaded into the stationary compactor. Several containers are used for salvageable scrap metal and are hauled away by a private contractor when filled. Another set of containers consisting of four Dinosaur containers store process waste. When the Dinosaur containers are filled, the containers are carried directly to the landfill. Two wastepaper trailers store nonprocess paper waste. The wastepaper trailers, when filled, are removed by a waste salvage company.

Solid waste handling within the plant is carried out by plant personnel while waste handling from the plant to the disposal site is by a private waste collector. All salvageable material, such as wastepaper, wood pallets, and scrap metal, is removed by private contractors in the waste salvage business.

The disposal site is a private landfill which handles primarily solid waste from the plastics production plant. All waste is compacted and covered daily with a layer of compacted soil.

Suggested areas of improvement are reduction of multiple handling of waste, relocation of the transfer area nearer the waste generation sources, and salvaging of useable pallets.

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* Mention of a specific product or equipment does not imply endorsement by the U.S. Public Health Service.

INTRODUCTION

The plastics production plant studied produces thermoplastic resins, thermosetting resins, and foam plastic products. The thermoplastic resins are produced in pelletized form in a variety of colors.

Waste collection within the plant is a joint effort between the company and several private contractors. An intra-plant collection system consisting of a flat-bed truck, a Dempster Dumpmaster*, forklifts, and a number of Dempster containers is owned and operated by the company. An extra-plant system is operated by the contractors. One contractor removes solid waste material from the plant to the landfill. Approximately $120,000 per year is paid to this contractor for his waste collection service. Equipment operated by this contractor includes: a tractor trailer, a Dinosaur tractor and Dinosaur containers, and a crawler tractor at the landfill. Another contractor salvages wastepaper within the plant and removes it in two large trailers. Scrap metal is also removed by a separate private contractor.

Further references as to the ownership of equipment used in waste collection are omitted within the body of this report.

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*Mention of a specific product or equipment does not imply endorsement by the U.S. Public Health Service.

METHODS AND PROCEDURES

The field study was conducted over a period of five days, the normal work week for the solid waste management employees at the plant. The study team consisted of three men at the plant on Tuesday, Wednesday and Thursday, four men on Monday, and two on Friday.

The first step in the study was to identify the components of the solid waste management system presently being utilized. This was accomplished by following the waste from its point of generation through storage, collection, and transfer procedures to its point of ultimate disposal.

Initially, an inventory was taken of storage areas and containers around the plant. At each location, the type and dimensions of the storage area and/or containers were recorded. As a result of this inventory, key waste transfer and collection areas were determined, and it was decided to concentrate our study efforts at these points. Waste handling activities in and around these key areas were observed. These activities included collection methods and the movement of waste materials into and out of storage areas.

In addition to the observation of waste handling activities in the plant, weights of waste being hauled were recorded. These records included not only weights of waste being removed from the plant but also weights of waste transferred internally from one

part of the plant to the other. Records of waste removed from the plant in previous years were obtained from the company.

Meetings were arranged with plant officials which enabled the study team to ask questions resulting from observations during the study. In addition, tours of various parts of the plant were given by plant personnel. These included a general tour of the process lines inside some of the main buildings and a tour of the process wastewater treatment plant.

SOLID WASTE MANAGEMENT SYSTEM

The solid waste management system is comprised of two subsystems which supplement each other: an intra-plant system for internal waste handling, and an extra-plant system for final removal of solid waste for disposal. The components of each system are complexly interrelated. This interrelation is best described in a schematic diagram (Figure 1).

To facilitate discussion of the system, each system component will be discussed in turn as the waste is followed through the diagram from source to disposal.

Sources and Waste Generation

Sources and wastes shall be considered in two categories: (1) process and (2) nonprocess. Process wastes include: bulk and pelletized plastic wastes which comprise the majority (by weight) of waste material removed from the plant (Table 1), defective insulation board, and process syrups. Nonprocess wastes include: office wastes (primarily paper), scrap metal (replaced parts and miscellaneous sheet metal), lawn clippings, cafeteria wastes, shipping wastes, street sweepings, demolition and remodeling debris and the like.

Solid waste generation was measured by weighing all solid waste stored in storage areas and containers excluding those

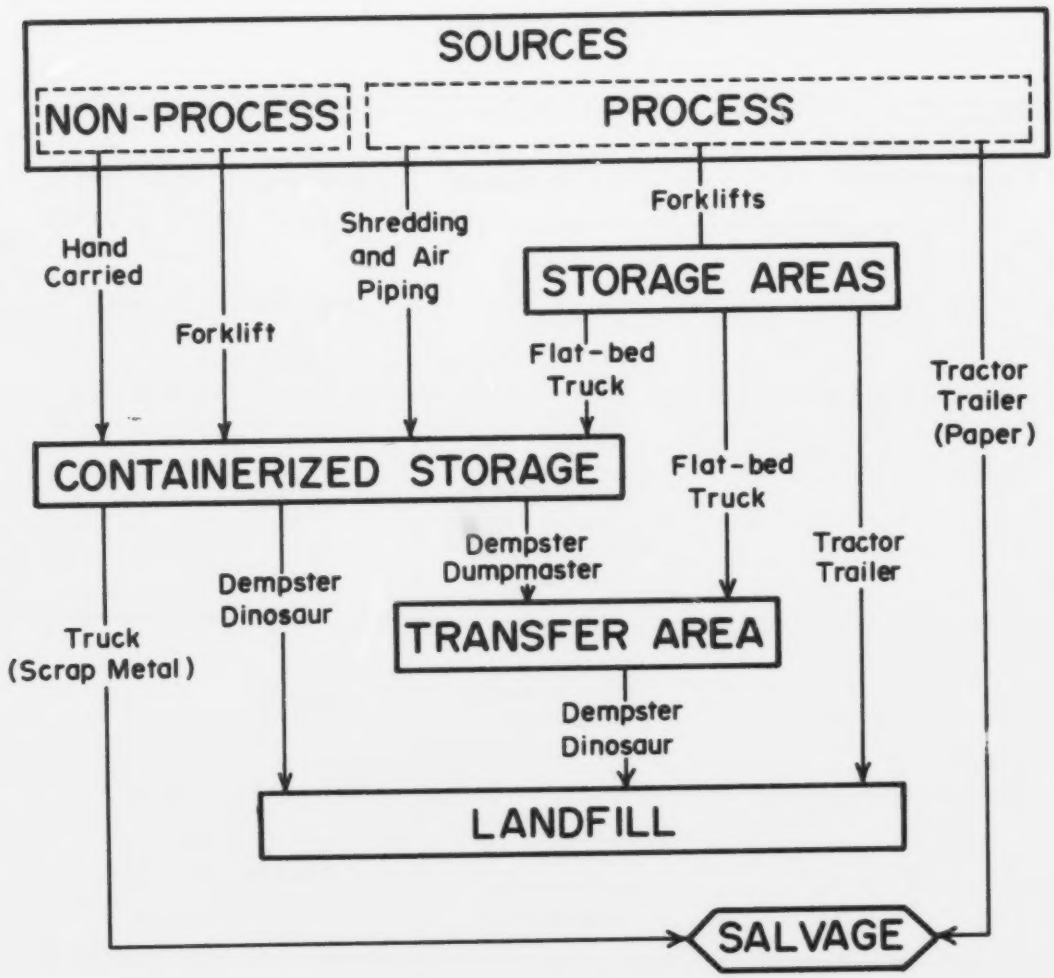

Figure 1. Solid waste management system.

TABLE 1

WASTE SOURCES

Building	Type of Waste	Amount of waste lbs/week*	% of total
A	Process plastic Nonprocess paper	259,320	70%
B	Process syrups Nonprocess paper bags barrels cardboard	49,680	14%
C	Process Nonprocess paper miscellaneous	23,120	6%
D	Process syrups Nonprocess paper	10,740	3%
E	Process insulation board paper	3,360	1%
General All Buildings (Dumpmaster Route)	Nonprocess scrap metal paper miscellaneous	21,820	6%
Treatment Plant	Process sludge	7,500 cubic feet	

*Amounts generated during the week of the field study.

located at the transfer area. Solid waste generated during the week of the study was 368,040 pounds (Table 2). During the same week, 368,940 pounds of solid waste were removed from the plant. This figure includes all solid waste hauled to the landfill and waste which was salvaged. The 900-pound discrepancy in the two figures can be attributed to a combination of three factors: (1) an accumulation of a small amount of waste at the transfer area during the previous weekend, (2) the use of standard tare weights for collection vehicles, and (3) weighing to the nearest 20 pounds on the scales. Approximately 43 percent of the waste generated, 158,340 pounds, was transferred internally by truck from storage areas and containers to the transfer area prior to removal. The remaining 57 percent was removed directly from the storage areas and containers to the landfill.

Weight records of solid waste collected by contractors since January 1967 indicate extreme variations in waste removed from week to week (Figure 2). Weekly variations from 126,400 pounds to 516,420 pounds have been recorded since that date. Part of the variation can be attributed to occasional six-day working weeks for the collection crew, but a large part of the variability is undoubtedly due to variations in the operation of the production lines. An analysis of the data indicated a trend of increasing weekly waste generation since January 1967 (Figure 2). The trend line is the line of best fit determined by the method of least squares. The trend line equation describes the curve using the

TABLE 2

WASTE GENERATION

(Date from the week of September 23-27, 1968)

Source	Monday	Tuesday	Wednesday	Thursday	Friday	Totals
Bldg. A	62,800	74,380	63,800	34,160	24,180	259,320
Bldg. B	22,280	6,220	5,860	7,820	7,500	49,680
Bldg. C	3,960	1,980	3,840	10,560	2,780	23,120
Bldg. D	5,460	320	540	2,180	2,240	10,740
Bldg. E	0	0	3,360	0	0	3,360
General All Bldgs.	4,760	4,940	7,340	3,040	1,740	21,820
Total	99,260	87,840	84,740	57,760	38,440	368,040

*Figures shown are in pounds.

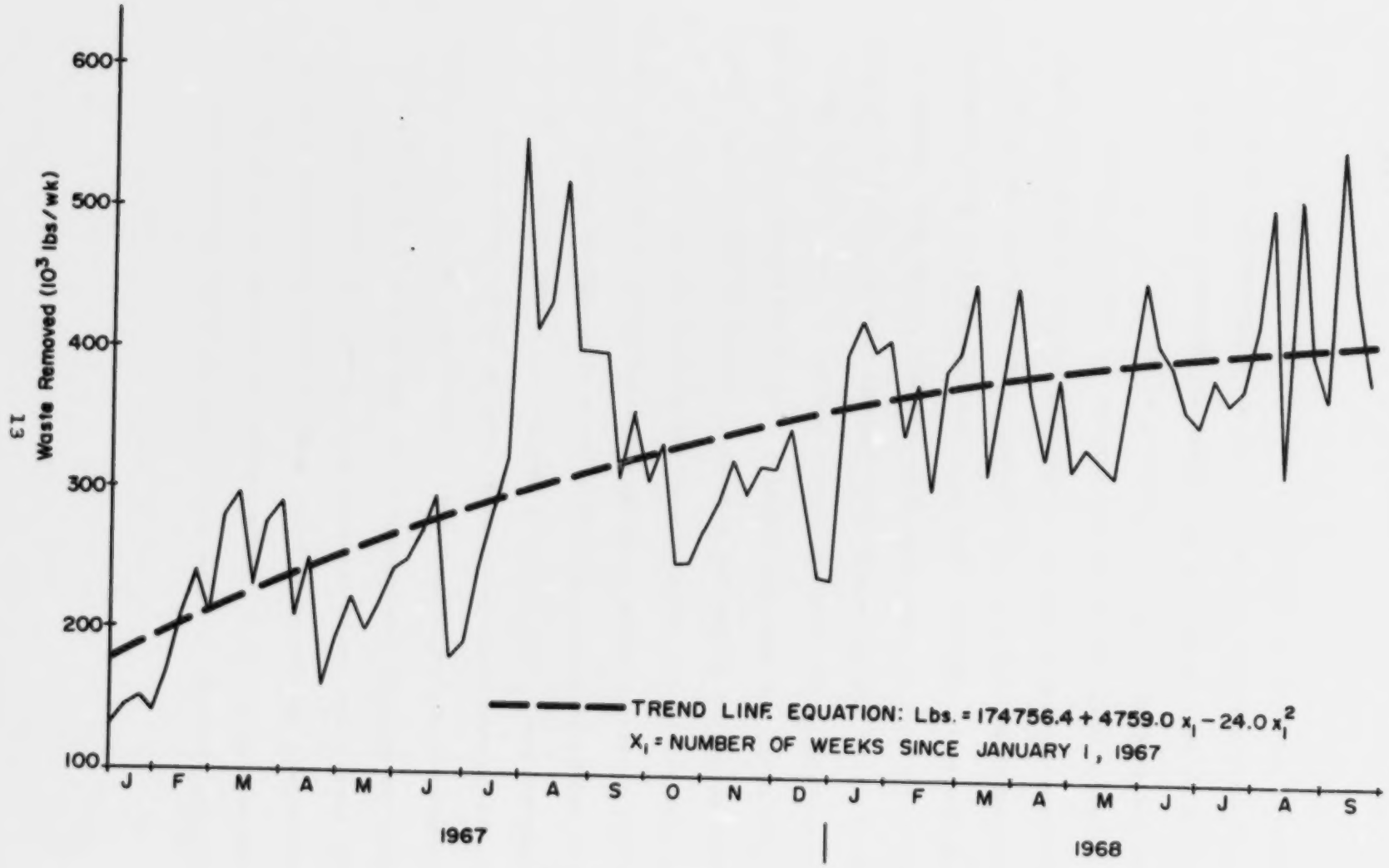
Waste Removed (10^3 lbs/wk)
600
500
400
300
200
100
TREND LINE EQUATION: Lbs. = 174756.4 + 4759.0 x_1 − 24.0 x_1^2
X_1 = NUMBER OF WEEKS SINCE JANUARY 1, 1967
J F M A M J J A S O N D J F M A M J J A S
1967
1968

Figure 2. Weekly waste removal.

number of weeks since January 1, 1967 as the independent variable. It may be noted that the quantity of waste removed has approximately doubled in the two years shown; there is, however, some indication that the rate of increase is leveling off.

Average daily waste removal figures for the nine months preceding the study show an interesting pattern (Figure 3). These daily averages indicate that Tuesday is the heaviest day of the week for waste removal. This fact was supported by data gathered during the week of the field study--92,460 pounds were removed on Monday while 100,580 pounds were removed from the plant on Tuesday. An explanation for this occurrence may be the fact that at the beginning of the week the transfer area is generally free of waste. Waste generated during the weekend is stored in the storage areas. In contrast to the transfer area these areas are quite full on Monday morning. Waste handling personnel spend three to four hours each Monday morning transferring waste from storage areas to the transfer area. This activity reduces the amount of waste which can be removed from the transfer area on Monday because the containers are not filled until mid-morning. Since waste removed from the transfer area accounts for approximately 43 percent of the total plant waste removed, waste removal is significantly decreased. On the other hand, weekend waste generation produces the same potential for waste removal on Tuesday as on Monday. By Tuesday, however, a large part of the waste has already been

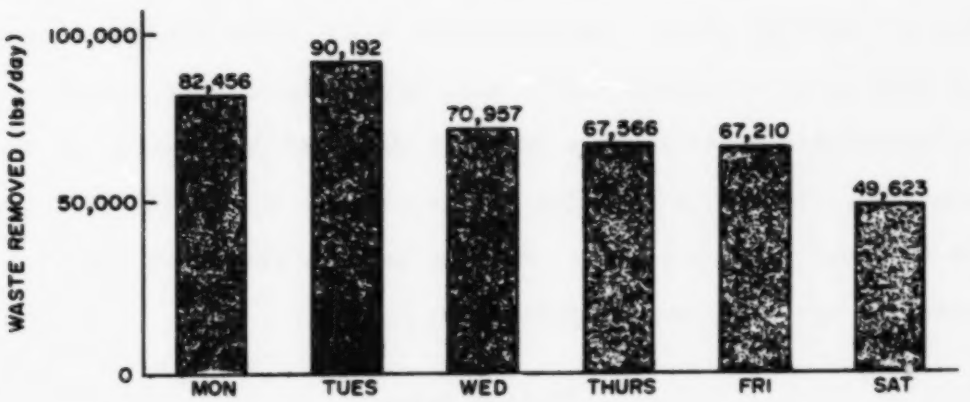

Figure 3. Average daily waste removed from the plant January 1968 to September 1968.

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transferred to the transfer area and containers are continuously being filled. As a result, the largest amount of solid waste is removed from the plant on Tuesday.

Solid waste is removed from the sources by three primary methods. Nonprocess wastes are either hand-carried or transported by forklift to some form of containerized storage. Process wastes are transported by forklift to storage areas or mechanically shredded and air-piped to containerized storage.

An additional solid waste source was identified at the wastewater treatment plant. Approximately 7,500 cubic feet of sludge is removed from process waters each week. Because of a lack of information concerning this waste, a detailed description of the handling, storage, collection or disposal of this waste will not be included in this report. Further details regarding this material are included in Appendix B.

Storage Areas

Six areas around the plant are used for temporary storage of waste materials prior to collection and disposal. The areas range in size from several hundred square feet to over four thousand square feet and serve all buildings in which major production activities are housed (Table 3).

TABLE 3

STORAGE AREAS

Storage Area	Building Served	Approximate Size
1	A	3,000 ft^2
2	D	300 ft^2
3	B	1,270 ft^2
4	C	400 ft^2
5	All	4,200 ft^2
6	E	9,400 ft^2

Waste placed in these storage areas is usually stored in some form of disposable container such as cardboard boxes and barrels. These containers are generally placed on wooden pallets to facilitate their transfer by forklift. One of the storage areas, however, utilizes no form of container. This area is storage area 5 which simply stores bulky scrap metal on the open ground.

Waste handling by the night shift creates some collection problems in the high-volume storage areas, especially storage area 1 near building A. During the study, cartons of pellets and bulky process wastes were spilled or dropped on their side by night employees. This resulted in collection personnel having to spend extra time cleaning up the area before waste could be removed. Additional personnel time is lost at this area because of poor allocation of storage space. The Dempster storage containers are normally blocked by boxes of waste which must be moved by hand before the Dempster Dumpmaster can empty the containers.

A flat-bed truck is used to collect and transport the solid waste from the storage areas to the transfer area. This truck makes five to ten trips daily (averaging 3,140 pounds/trip) serving storage areas 2-4 with occasional trips to storage area 1. When the waste arrives at the transfer area it is either placed in the open area prior to being compacted in the stationary compactor or placed in the high or low-side Dinosaur containers for removal.

A tractor trailer is used for hauling material from storage area 1 directly to the landfill. Three to four loads (averaging 12,440 pounds/trip) are hauled from the plant each day.

Containerized Storage

A series of containers placed throughout the plant store solid waste material until it is removed for disposal. The containerized storage can be divided into two systems: (1) an intra-plant system and (2) an extra-plant system.

The intra-plant system consists of containers used for the storage of waste until it is transferred to the transfer area or salvaged. Two types of containers make up this system: Dempster containers and scrap metal containers. Dempster containers store nonsalvageable wastes and scrap metal containers store old metal parts, sheet metal scrap, etc. These containers are located throughout the plant for convenience of collection.

The Dempster containers are collected daily by the Dempster-Dumpmaster. The collection is made in the morning and averages 65 minutes to complete the route. An average load during the study weighted 4,050 pounds. This waste is taken to the transfer area and discharged into the stationary compactor.

The scrap metal containers are collected by a private contractor. The contractor is notified when the containers are filled, and he purchases the scrap metal on a price-per-pound basis.

The extra-plant system consists of four Dinosaur containers and two wastepaper trailers collected by private contractors (Table 4). The four Dinosaur containers are removed from the plant using the Dinosaur tractor. They are: (1) an enclosed air-fed container for shredded polystyrene foam located near building E, (2) a high-side container, (3) a low-side container for unshredded insulation board waste and syrups located at the transfer area, and (4) an enclosed container connected to the stationary compactor at the transfer area. Two wastepaper trailers complete the extra-plant system and are located near building E and building A. These trailers store salvageable paper and are removed by a private scrap dealer at the request of the company at intervals of approximately one month and two weeks respectively.

Transfer Area

The transfer area (Figure 4) is the coordinating point for intra-plant and extra-plant collection systems. At the transfer area, waste is transferred from the intra-plant collection trucks (flat-bed and Dumpmaster) to the extra-plant containers (high-side, low-side, and the stationary compactor containers). The stationary compactor is the most important single item. It is used to compact bulky, low-density wastes which can be compressed. The wastes are placed in the open area until the Dinosaur container is

TABLE 4

EXTRA-PLANT CONTAINERS

Container	Building Served	Approximate Size
Air-fed	E	1,160 ft^3
High-side	E & D	860 ft^3
Low-side	C & D	540 ft^3
Compactor	All	860 ft^3
Paper trailer	E	2,370 ft^3
Paper trailer	A	1,570 ft^3

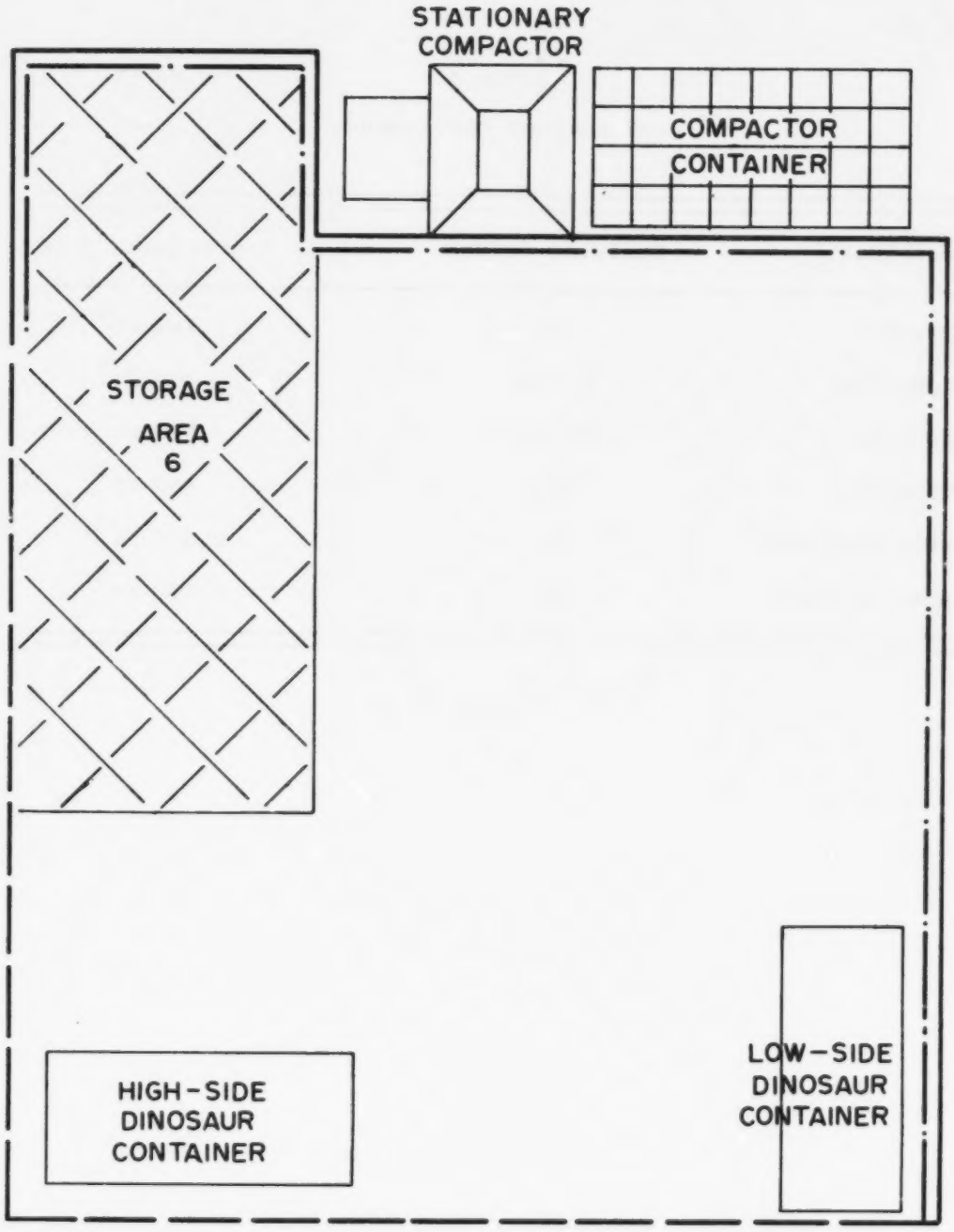


Figure 4. Transfer area.

connected to the compacting ram and hopper. Wastes are then loaded into the hopper from either the flat-bed truck directly, the Dempster Dumpmaster, or the open area by the forklift. When full, the Dinosaur container is removed from the stationary compactor by the Dinosaur tractor. All waste at the transfer area is hauled away in the containers using the Dinosaur tractor (Table 5).

An attempt is made to salvage reusable pallets. Workmen remove pallets from the hopper of the stationary compactor whenever possible.

Landfill

A privately operated 100-acre sanitary landfill, located on a farm 11.1 miles from the plant, is used for disposal. This landfill is a ravine and used primarily for the disposal of waste from the plant. The site has a dirt access road which winds down a moderate grade. The road is passable in all weather conditions but becomes extremely muddy during wet weather. It is often necessary for trucks to be pulled out of the site with the aid of the tractor.

One man is present at the site at all times to supervise the unloading and to operate the landfill equipment. The operator, using a crawler tractor with a multipurpose bucket, spreads, compacts, and covers the waste daily with a layer of soil.

TABLE 5

DAILY WASTE REMOVAL FROM THE TRANSFER AREA

Monday	Tuesday	Wednesday	Thursday	Friday	Total
31,560 lb	39,040 lb	17,980 lb	28,780 lb	41,880 lb	159,240 lb

The estimated remaining life of the site is ten years at the present level of use with a planned eventual use as a golf course.

Salvage

Three materials are presently being salvaged from the plant wastes: scrap metal, wooden pallets, and wastepaper. Assorted scrap metal is collected in two containers marked "scrap metal only" located near building F and in storage area 5. The scrap metal is sold to a local scrap dealer at the market price for unsorted metal scrap.

Pallets are salvaged at storage area 1, at the transfer area, and at the landfill. Waste handling personnel within the plant generally attempt to salvage pallets which they believe can be reused. The private contractor also salvages pallets at the landfill and sells them to a pallet distributor. Approximately 450 pallets were observed in a pile at the landfill, and it is estimated that 60 to 80 pallets are salvaged out of the waste each day. Careful use of these pallets by waste handling personnel and attempts to salvage more of these could result in savings to the company.

Wastepaper is collected at two points within the plant in large trailer bodies. One of the trailers collects waste paper rolls from the insulation board process line. It is estimated about 27,750 pounds of this material is collected each month. The

other trailer, located near building A, collects waste shipping boxes and packaging waste. About 63,240 pounds of wastepaper material is collected from the building monthly. All wastepaper is sold to a local scrap dealer who hauls away the trailer when notified by the company.

Discussion

While the methods presently used at the plant for solid waste handling are generally effective and carried out in an acceptable manner, a number of inefficiencies in solid waste handling were observed during the course of this study.

A major inefficiency is in the multiple handling of waste materials. Solid waste materials presently are being handled from two to five times before leaving the plant. In the extreme case, waste is: (1) removed from a building by forklift and placed in the storage area; (2) reorganized within the storage area (in cases of careless handling by the night shift); (3) loaded onto a truck, either a flat-bed or tractor trailer; (4) in the case of the flat-bed, unloaded at the transfer area; (5) and finally placed into one of three containers at the transfer area for removal from the plant. Even at best, waste materials being hauled by the tractor trailer are handled a minimum of two times before being removed.

Dempster containers in storage area 1 are not being utilized efficiently. Presently they are located within storage area 1

and cannot be easily reached and emptied by the Dempster-Dumpmaster when the area is filled. This occurs the first part of every week.

Waste removal activities within the plant are concentrated at two locations: at storage area 1 and at the transfer areas. While storage area 1 is near the major source of waste within the plant, building A, the transfer area is relatively distant from the sources of waste generation. The result of the present location of the transfer area is time consuming waste transfer practices. Relocation of the transfer area activities near storage area 1 would reduce the transfer time and at the same time centralize waste collection activities in one area of the plant.

During the survey, the study team observed that between 85 and 105 usable pallets were discarded each day. The pallets are the type generally used around the plant for waste handling. Since these pallets are presently purchased for $1.75 each, the company might save from $150/day to $185/day by salvaging rather than discarding the pallets.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions regarding the company solid waste management system (assuming waste will continue to be removed by truck) are listed below:

1. Multiple handling of waste materials could be eliminated by directly loading waste materials from the buildings into disposal vehicles or containers. This could require the complete revision and relocation of high volume storage areas such as storage area 1 near building A. A revision of this area would involve a change in the waste handling procedures. Waste presently being placed in the storage area and then transferred to the trailer could be loaded directly into the trailer if it remained in the plant. Trailers could then be removed when full, and waste would be handled only once before removal. This system could also eliminate the present unsightly appearance of storage area 1.
2. An attempt could be made to salvage usable pallets within the plant. Considerable savings (approximately $170/day) might be realized through the salvaging of these pallets. If it appears this is impractical, the possibility of using a pallet made of cheaper material such as cardboard should be explored. A cheap, disposable pallet could be used in the waste disposal operation and then disposed of with the waste material.

3. Dumpster containers presently in storage area 1 should be removed and either relocated or sold. They presently are occupying usable space and are unusable part of the time. Waste presently being discarded in them could be placed in cardboard containers similar to those used for process wastes in storage area 1.

4. The relatively long distances separating the transfer area and the storage areas it serves results in wasted time in the transport of material from these sources to the transfer area for removal. Consolidation of the waste removal activities near building A, although initially expensive, should be investigated in terms of its future desirability. Centralization of waste removal activities in this area would substantially reduce the travel distance required in intra-plant waste movements.

5. The high-side and low-side Dinosaur containers which are presently used to remove waste syrup in barrels should be relocated in storage area 2 or 3 so they will be closer to the source of this waste. This would eliminate another instance of multiple handling of material since the wastes could be loaded directly into these containers.

6. Waste records now compiled by plant personnel should be periodically analyzed as a check on the operating efficiency of the overall plant production activity. If waste output

should increase rapidly as a result of no apparent change in production activity, the examination of these records might pinpoint the source of increased waste generation. Proper adjustments could then be made to eliminate the problem.

APPENDICES

APPENDIX A

As a result of this study, insight was gained into the necessary planning and preparation which must be completed before the initiation of the field evaluation aspect of an industrial solid waste management study. Some of the considerations which should accompany a study of this type are listed below:

1. The study team should be well-informed about the plant layout and operation before the field evaluation is begun. The project officer or engineer in charge during the study should become thoroughly familiar with the plant, the waste collection and disposal operation, and the equipment used in the operation. This would provide time for him to meet with the members of the study team and brief them before the data collection phase of the study begins. This is necessary to insure that the study will proceed smoothly and with a minimal amount of inconvenience to employees of the plant. The briefing should include explanation of pertinent processes, distribution of plant maps, a general overview of the disposal operation and identification of data to be gathered during the study.
2. Data on capital cost of the facility, square footage of buildings, plant output, power generation, and waste

disposal often require time to be cleared for release by the proper plant officials and should be requested as early as the need for such information is determined.

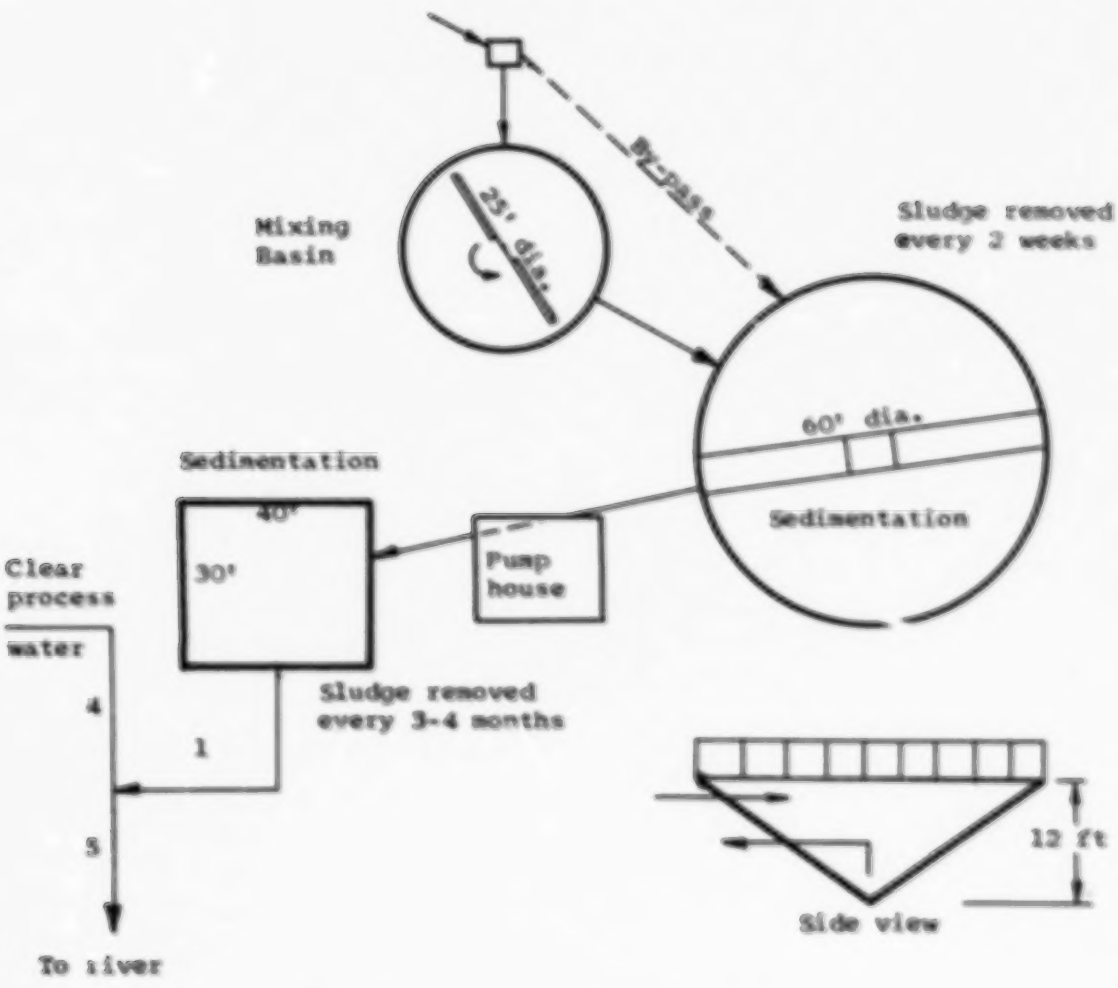
3. Proposed correlations of the above data with the waste output of a given industry is crude at best, and the choice of a reliable predictor variable (waste generation/plant index, e.g. lbs. waste/kwh power utilized) is difficult. Until several industries of the same type have been studied thoroughly, the identification of the proper variable cannot be easily determined.

GROSS WEIGHTS HAULED DURING THE STUDY*

	Monday	Tuesday	Wednesday	Thursday	Friday	Totals
Flatbed	11 loads 33,600	10 loads 21,360	10 loads 35,360	8 loads 31,960	3 loads 15,840	138,120
Dempster-Dumpmaster	1 load 4,760	1 load 4,940	1 load 5,740	1 load 3,040	1 load 1,740	20,220
Tractor Trailer	4 loads 60,900	4 loads 61,540	3 loads 40,280	3 loads 22,760	3 loads 25,980	211,460
Dinosaur	3 loads 31,560	4 loads 39,040	3 loads 21,340	3 loads 28,780	3 loads 36,760	157,480
Totals	130,820	126,880	102,720	86,540	80,320	527,280

*Figures shown are in pounds

APPENDIX B



WASTEWATER PLANT

Approximately 620,000 gal/day plant
Average of 7,500 ft^3 per week of sludge removed to lagoon for disposal
Process water used to dilute effluent 4 to 1
Heavy wastewater flow at shift change